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ABSTRACT

This curriculum guide for industrial ceramics courses is part of a series of curriculum guides for use in the industrial arts curriculum in Connecticut. The guide provides information on the scope and sequence of the industrial arts curriculum, specific guidelines for industrial arts, and program goals and objectives. The content of the industrial ceramics courses is outlined, with major divisions noted as follows: (1) cultural applications; (2) ceramic industries; (3) consumer products divisions; (4) materials; and (5) processes. In addition, student and teacher activities are suggested for each of these five areas. The guide also contains references and local sources of industrial ceramics information. (This curriculum guide provides material for both secondary and adult vocational education courses in industrial ceramics.) (KC)

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INDUSTRIAL ARTS CURRICULUM GUIDE

FOR

INDUSTRIAL CERAMICS

Connecticut State Department of Education

Division of Vocational and Adult Education

Bureau of Vocational Services

May, 1982

CE 034 031

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TABLE OF CONTENTS

Connecticut State Board of Education 1

Disclaimer 2

Industrial Ceramics Committee Members 3

Introduction 4

Industrial Arts Scope and Sequence 6

Specific Guidelines for Industrial Arts 11

Industrial Ceramics Phase I - Flow Chart 17

An Explanation of the Outline System 18

Industrial Ceramics Phase II - Content Outline . . 19

Industrial Ceramics Phase III - Teacher & Student Activities 42

Industrial Ceramics Phase IV - References . . . 48

Local Sources of Industrial Ceramics Information . . 52

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Special thanks to the Indiana Industrial Arts Association.

INTRODUCTION

The committee developed this curriculum to be used on any grade level in an industrial arts program. Many areas are covered in it and the teacher starting a program should investigate all the areas and determine what can be used in that particular laboratory. The equipment available can guide the teacher but through creativity and Yankee know how the various units can be taught with limited equipment.

Industrial Ceramics should be a part of every industrial arts program. This will provide the student with the knowledge and experience to work in this area.

Industrial Ceramics is one of the oldest industrial fields in the United States. Ceramics manufacturing is carried in every state. It covers vocational as well as avocational pursuits, manufacturing house bricks, blocks, bathroom fixtures, furniture, garden ware and others to the recreational ceramic class.

The reference list should be reviewed and the teacher should select the materials that seem to best fit into their program of industrial arts.

The list of equipment is basic but it is also what would be used to run an excellent industrial ceramics program.

INDUSTRIAL ARTS SCOPE AND SEQUENCE

Industrial Arts learning experiences are sequential, beginning in the lowest grades and continuing through adult and higher education. As an integral part of the total educational program, Industrial Arts is designed to meet student's needs as they relate to a modern technological society. Through manipulative and research experiences, with a variety of tools, machines, processes and products of industry, students develop an awareness of how industry and its many components function.

A comprehensive Industrial Arts program will provide for a sequence of courses in industrial areas. These include, but are not limited to:

drafting	industrial ceramics
electricity/electronics	metal technology
general lab	plastic technology
graphic arts	power technology

wood technology

The objectives of Industrial Arts are:

..... To develop an insight and understanding of industry, its

place in our society, and the free enterprise system.

..... To develop problem solving skills related to the materials, tools, processes and products of industry.

..... To provide for a degree of skill development through a series of sequential courses in common industrial areas with vocational emphasis at the advanced levels.

..... To develop knowledge of the tools, machines, materials, and processes of industry through their practical and safe use.

..... To develop an appreciation of good design and craftsmanship.

..... To develop an understanding of industrial and technological career opportunities and their requirements.

..... To develop those traits which will help students obtain and maintain employment.

..... To develop consumerism regarding the goods and services of industry.

..... To discover avocational and recreational interests.

..... To understand the affects of industry and civilization upon the environment.

The following sequential phases represent a range of Industrial Arts activities from kindergarten through adulthood. Reference is made to grade level to assist LEA's in planning. It is understood that a wide variety of grade organizations are employed based upon local situations.

I. Self-Awareness (grades K-6)

Industrial Arts at this level is designed to familiarize students with the many kinds of work people do and the tools and materials they use. It is at the elementary level that Industrial Arts activities are used to enhance basic skills and understandings in all curricular areas by providing relative hands-on experiences.

II. Industrial Arts Exploration (grades 7 & 8)

Industrial Arts at the middle school/jr. high school level is designed to foster the development of a strong foundation in the concepts, skills, knowledges and attitudes regarding not only the technical but also the related and social aspects of general education.

Industrial Arts experiences at this level are exploratory in nature. The program provides students with the opportunity to develop a better understanding of their interests, abilities and aspirations. Consumer knowledge as it relates to industrial products and processes is an inherent part of these activities. A broad exploratory Industrial Arts program at the middle school/jr. high school level allows individual student's interests to become more discernible for concentration at the senior high level.

III. Industrial Arts Occupational Orientation (grades 9 & 10)

Industrial Arts at this level emphasizes occupational orientation. It is here that the transition from middle school/jr. high school exploratory experiences to specialization at the upper levels is made. Students may explore in greater depth a wider variety of areas, evaluate their performance, aptitudes and interests and begin to formulate career plans.

IV. Industrial Arts Specialization (grades 11 & 12)

At this level students are provided the opportunity to specialize in one or more occupational areas and to develop pre-vocational skills. Training at this level should prepare students to maximize their career options after high school.

This level should also assist individuals in making informed and meaningful occupational choices and/or prepare them for entry into advanced trade and industrial or technical education programs.

V. Adult, Continuing and Higher education Industrial Arts programs are designed for adults and out of school youth. These programs are avocational, pre-vocational or vocational in nature depending upon the needs of the individual and the demands of society.

SPECIFIC GUIDELINES FOR INDUSTRIAL ARTS

Grade Level

7 - 12 and Adult

Selection of Students

Open to all students who can profit from instruction, and work safely in a Lab/Shop situation

Length of Program

Level One (Exploratory) grades seven (7) and eight (8) - Lab/Shop classes meet a minimum of 60 hours per year. Lab/Shop periods must be of at least 40 continuous minutes and should not exceed 60 minutes.

Level Two (Occupational Orientation) grades nine (9) through twelve (12), or grades ten (10) through twelve (12) - students electing Level Two Industrial Arts courses must have the opportunity to participate in a minimum of 225 minutes of Lab/Shop activities per week, per semester. Daily Lab/Shop periods must be of at least 45

continuous minutes and should not exceed 60 minutes.

Level Three & Four (Specialization and Pre-Vocational) grades eleven (11) and twelve (12). Students that elect Level III & IV Industrial Arts courses must have a minimum of 450 minutes per week, per year of Lab/Shop activities. Daily Lab/Shop periods must be of at least 90 continuous minutes.

The definition of a year is a minimum of 180-day school days. A semester is 90 continuous school days.

Pre-Requisites

Successful completion of Level Two course prior to participating in Level Three. Successful completion of Level Three course prior to Level Four.

Enrollments

Based on Lab/Shop size and facilities, 16 students per class maximum in Lab/Shop areas and 20 students per class in drafting. The recommended and minimum square footages are as follows:

	Recommended		Minimum	
Jr./Sr. High School	s.f./pupil station	Net total s.f. area	s.f./pupil station	Net total s.f. area
Drafting (inc. storage)	48 sf	1200 sf	40 sf	1000 sf
I.A. Jr. H.S. Level One (inc. storage)	100 sf	2500 sf	82 sf	2050 sf
I.A. Sr. H.S. Levels Two, Three & Four (inc. storage)	144 sf	3600 sf	120 sf	3000 sf

A classroom should be made available for related study, adjacent to the Shop/Lab areas. All facilities must comply with OSHA regulations.

Teachers Schedule

Industrial Arts contact hours for a full-time instructor should comprise 70% to 80% of their school week, and 20% to 30% of their time in industrial arts related non-teaching duties, such as maintenance and preparation of I.A. materials.

Equipment

All equipment must be in safe operating condition and conform to all federal, state, and local standards. Equipment must be:

A. Applicable to the level being taught, i.e., size, capacity, quantity, and necessity.

B. Enhance the program level and be similar to that found in industry.

C. Take into consideration: occupational education, consumer competency, leisure time activity, and environmental awareness.

Evaluation

Continuous evaluation by students, teachers, school, vocational, advisory committee, and state. Evaluation results must become an integral part of program development and improvement.

School Credit

Equal to other academic credit granted for similar periods of time and activities.

Youth Organizations

It is recommended that the American Industrial Arts Student Association (AIASA) be an integral part of the curriculum.

Teacher Certification

Instructors shall meet the minimum standards for Industrial Arts teachers provisional certification as outlined in the "Rules and Regulations Concerning State Teacher Certification" section 10-146-21 and section 10-146-22.

Standard certification requires three (3) years of teaching under a provisional certificate, the last two (2) years consecutive and a master's degree or thirty (30) semester hours, consisting of a planned program at an approved institution of higher learning and an individual program, mutually determined and approved by teacher and supervising agent.

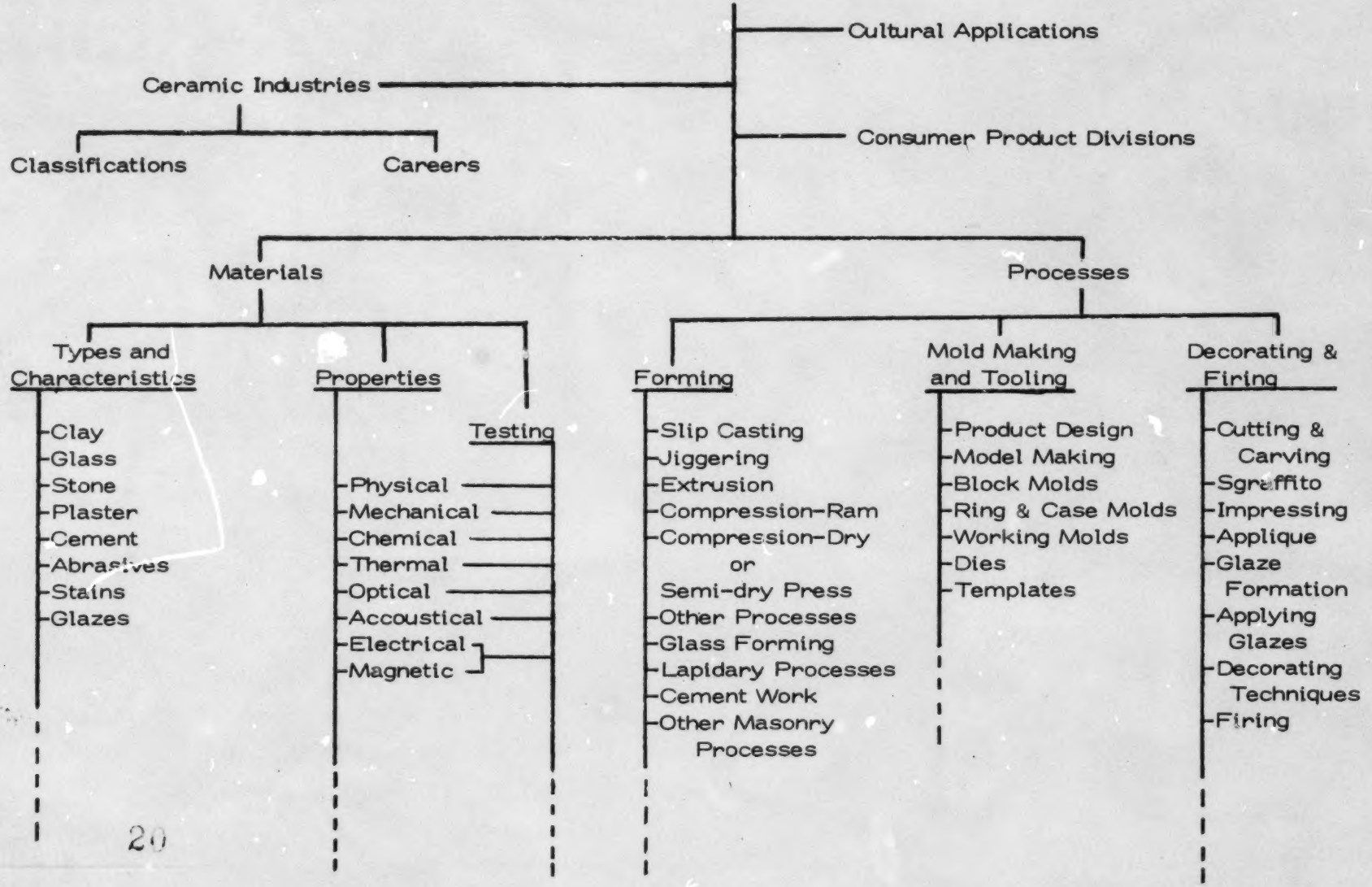
Teachers of Industrial Arts to be funded through the Vocational Education Acts must comply with section 10-146-22 above, have one (1) year of appropriate occupational experience and complete Principles of Vocational

Education, a three (3) semester hour Vocational-Technical Education course.

Sex Stereotyping

Existing activities and future plans must show evidence of actions directed toward the elimination of sex stereotyping, including continual effort to attract females to elective industrial arts courses traditionally chosen by males. Industrial arts courses which are required for any students at a particular level must be required of all students, male and female.

INDUSTRIAL CERAMICS PHASE I - FLOW CHART



AN EXPLANATION OF THE OUTLINE SYSTEM

The following is a comparison of the number outline system with the traditional outline format.

1.0 Major Division.....I.
1.1 Categories of a Major Division.....A.
1.1.1 Subheadings of a category.....1.
1.1.1.1. Subhead of the second degree..a.
1.1.1.1.1. Subhead of the third degree.....(1)
1.1.1.1.1.1. Subhead of the fourth degree..(a)
1.1.2 Subhead of category parallel to 1.1.1 above..2.
1.2 Category parallel to 1.1 above.....B.

2.0 Major Division parallel to 1.0 above.....II.

A major advantage for using the number outline system was in the ease of cross-referencing. Activities and references are easier to locate and type by numbers such as 3.2.1.1.5 rather than III, B, 1, a, (5). Additionally the number system allows one to subdivide to the degree needed. Though not as recognized by as many persons, it is in common use in governmental and agency documents. It's perhaps part of our education to cope with either.

The I.A. Central Curriculum Committee of the I.I.E.A.

INDUSTRIAL CERAMICS PHASE II

CONTENT OUTLINE

1.0 Cultural Applications

1.1 Earliest Times

1.1.1 Eras and products

1.1.2 Great people and great achievements

1.2 Present Status and Social Implications

1.2.1 American ceramic industries

1.2.2 Ceramic products and rising standard of living

1.2.3 Restoration of mined land

1.2.4 International economic aspects

1.3 Futuristic Outlook

1.3.1 Changing nature of jobs

1.3.2 New ceramic industries

1.3.3 Revolutionary changes in concepts

2.0 Ceramic Industries

2.1 Classifications

2.1.1 Whitewares--dishes, bathroom, chemical and sanitary porcelain

2.1.2 Structural clay--brick, tile

2.1.3 Optical--lasers, phosphors, pigments

2.1.4 Ceramic-metal--glass metal seals, ceramic metal seal, cermets, slags

2.1.5 Oxide ceramics--metal tooling, electrical uses

2.1.6 Refractories--asbestos products, heat absorbing gloss

2.1.7 Stone--architectural, precious, semiprecious, synthetic

2.1.8 Cement

2.1.8.1 Cement

2.1.8.1.1 Hydraulic

2.1.8.1.2 Keene

2.1.8.1.3 Portland

2.1.8.1.4 Lime

2.1.8.1.5 Gypsum

2.1.8.2 Gypsum products

2.1.9 Electro-ceramics--capacitors, magnetics, resistors

2.1.10 Glass

2.1.10.1 Flat

2.1.10.2 Laminated

2.1.10.3 Fiber

2.1.10.4 Glaze

2.1.10.5 Enamel

2.1.10.6 General consumer products

2.1.11 Abrasive--natural, synthetic

2.1.12 Nuclear--fuel elements, moderators, heat exchange

2.1.13 Aerospace--turbine blades, rocket nozzles, nose cones, radiation suppression coating

2.2 Careers

2.2.1 Classification

2.2.1.1 Unskilled

2.2.1.2 Semiskilled

2.2.1.3 Skilled

2.2.1.4 Professional

2.2.2 Orientation to careers

2.2.2.1 Description of job classification

2.2.2.2 Training and educational requirements

2.2.2.3 Wages

2.2.2.4 Examples by classification of industries and career levels

3.0 Consumer Products Divisions

- 3.1 Stone
- 3.2 Glass--flat-embossed, stained, pressed, blown, containers
- 3.3 Cement
- 3.4 Structural clay products--brick, tile, stoneware
- 3.5 Refractories--clay, asbestos heat insulation
- 3.6 Whiteware
  - 3.6.1 Porcelain
  - 3.6.2 Floor and wall tile
  - 3.6.3 Vitreous sanitary ware
  - 3.6.4 Vitreous plumbing fixtures
  - 3.6.5 Vitreous china utensils
  - 3.6.6 Porcelain electrical supplies
- 3.7 Abrasive products--natural, synthetic
- 3.8 Ceramic minerals
  - 3.8.1 Oxides
  - 3.8.2 Feldspar
  - 3.8.3 China clay
  - 3.8.4 Kentucky ball clay
  - 3.8.5 Flint and silica
  - 3.8.6 Glaze materials

3.9 Vitreous enamel ware

3.9.1 Sanitary ware

3.9.2 Plumbing fixtures

3.9.3 Food utensils

3.9.4 Stone equipment

3.9.5 Metal stamping enamel products

3.9.6 Refrigeration machinery parts

3.9.7 Electrical appliance parts

3.10 Semivitreous products--tableware, wall tile

3.11 Ceramic-metals

3.12 Electrical-ceramics

3.13 Opticals

3.14 Nuclear

3.15 Aerospace

4.0 Materials

4.1 Types and characteristics

4.1.1 Clay--an abundant raw material

--soft and pliable in raw form

--hardens and fuses after firing

4.1.1.1 Primary class

4.1.1.2 Secondary or sedimentary class

4.1.1.3 Bodies

4.1.1.3.1 Natural bodies

4.1.1.3.1.1 Plastic vitrox

4.1.1.3.1.2 Sandy Kaolin

4.1.1.3.1.3 Stoneware clay

4.1.1.3.2 Mineral bodies

4.1.1.3.2.1 Kentucky ball clay

4.1.1.3.2.2 Georgia Kaolin

4.1.1.3.2.3 Potter's flint

4.1.1.3.2.4 Potash feldspar

4.1.1.3.2.5 Tennessee ball clay

4.1.1.3.2.6 Bell's ball clay

4.1.1.3.3 Pottery bodies

4.1.1.3.3.1 Earthenware--red firing, red grog, white-firing, talc, sculpture, Indian red

4.1.1.3.3.2 Stoneware bodies--red, gray, and grog stoneware; Basalt, Jasper

4.1.1.3.3.3 Porcelain--Parian, Syenite, electrical, high fired, frit, and bone china

4.1.1.3.4 Refractory bodies

4.1.1.3.4.1 Fire-clay

4.1.1.3.4.2 Alumina

4.1.1.3.4.3 Silicon carbide

4.1.1.3.4.4 Insulating

4.1.1.3.5 Commercial bodies

4.1.1.3.5.1 Cone 010 containing frit

4.1.1.3.5.2 White firing non-talc

4.1.1.3.5.3 White firing talc

4.1.1.3.5.4 Buff, red, and white burning

4.1.1.3.5.5 Terra cotta with grog

4.1.1.3.5.6 Low fire clay

4.1.1.4 Consistencies

4.1.1.4.1 De-aired moist modeling

4.1.1.4.2 Airfloated dry modeling

4.1.1.4.3 Casting slip liquid

4.1.1.4.4 Casting dry

4.1.2 Glass--raw material with wide color range from opaque to transparent

--hard and brittle material

--good optical characteristics

--high melting temperatures

4.1.2.1 Soda lime

4.1.2.2 Lead alkale

4.1.2.3 Borosilicate

4.1.2.4 Alumino-silicate

4.1.3 Stone--a raw material with excellent weathering characteristics

--extremely wide variety

--strong but brittle material

4.1.3.1 Igneous

4.1.3.2 Sedimentary

4.1.3.3 Metamorphic

4.1.3.4 Precious, semiprecious

4.1.3.5 Synthetic

4.1.4 Plaster (gypsum)--a refined raw material

--light weight and fragile

--hardening due to basic chemical reaction-calcining

4.1.5 Cement--a refined raw material

--hardening due to basic chemical reaction

--a dense and strong material

4.1.5.1 Gypsum

4.1.5.2 Portland

4.1.6 Abrasives--extremely hard

--fractures product sharp edges

--excellent wearability

4.1.6.1 Natural--abundant, varying hardness

4.1.6.2 Synthetic--economical, long wearing

4.1.7 Stains

4.1.7.1 Colored bodies--white, pink, yellow

4.1.7.2 Commercial body stains

4.1.7.3 Commercial glaze stains

4.1.8 Glazes

4.1.8.1 Types

4.1.8.1.1 Low-fire--lead, alkaline

4.1.8.1.2 High-fire

4.1.8.1.3 Special glazes--frit, crackle, matt

4.1.8.2 Oxides used in glazes--basic, neutral, acid

4.1.8.3 Colorants and colors

4.1.8.4 Opacifiers

4.1.8.5 Underglaze

4.1.8.5.1 Semi-moist

4.1.8.5.2 Liquid

4.1.8.5.3 Underglaze crayons

4.1.8.6 Overglaze

4.1.8.6.1 Semi-matt

4.1.8.6.2 Matt

4.2 Properties

4.2.1 Physical--the intangible and nontechnical characteristics

4.2.1.1 Color

4.2.1.2 Shape

4.2.1.3 Size

4.2.1.4 Feel

4.2.1.5 Appeal

4.2.1.6 Etc.

4.2.2 Mechanical--the behavior of a ceramic material under varying conditions of stress

4.2.2.1 Hardness

4.2.2.2 Strength

4.2.2.3 Durability

4.2.2.4 Elasticity

4.2.2.5 Hardening qualities

4.2.2.6 Weatherability

4.2.2.7 Porosity

4.2.3 Chemical--the demonstrable characteristic of ceramics in the presence of other materials --the specific chemical make-up of the ceramic material

4.2.3.1 Acidity and alkalinity

4.2.3.2 Resistance to acids, water, solvents, etc.

4.2.3.3 Weatherability

4.2.3.4 Effect of drying or setup

4.2.3.5 Effect of firing

4.2.4 Thermal--the resistance of a ceramic material to or the behavior of a ceramic material in the presence of heat

4.2.4.1 Heat insulation

4.2.4.2 Temperature resistance

4.2.4.3 Melting point

4.2.4.4 Softening point

4.2.4.5 Annealing

4.2.4.6 Tempering

4.2.4.7 Fritting

4.2.4.8 Firing

4.2.4.9 Thermal expansion

4.2.5 Optical--the visual characteristic of a material in the presence of light

4.2.5.1 Color

4.2.5.2 Reflection

4.2.5.3 Refraction

4.2.5.4 Chatoyance

4.2.5.5 Asterism

4.2.5.6 Transparency-translucency

4.2.5.7 Opaqueness

4.2.6 Accoustical--the characteristics and properties of a ceramic material in a sound wave

4.2.6.1 Sound transmission

4.2.6.2 Sound reflection

4.2.6.3 Sound absorption

4.2.7 Electrical--technical behavior of a ceramic material subjected to electrical current

4.2.7.1 Conductivity

4.2.7.2 Super conductivity

4.2.7.3 Dialectric properties

4.2.7.4 Electrical insulation

4.2.7.5 Ferroelectric

4.2.8 Magnetic--behavior in a magnetic field

4.2.8.1 Magnetic permeability

4.2.8.2 Ferromagnetic behavior

4.3 Testing

4.3.1 Physical tests--intrinsic-intangible analysis

4.3.1.1 Consumer testing

4.3.1.2 Consumer sampling

4.3.1.3 Market analysis

4.3.2 Mechanical tests

4.3.2.1 Tensil

4.3.2.2 Flexure

4.3.2.3 Compressive

4.3.2.4 Impact

4.3.2.5 Rockwell hardness

4.3.2.6 Shear strength

4.3.2.7 Elasticity

4.3.2.8 Deformation

4.3.2.9 Shrinkage

4.3.2.10 Effect of firing

4.3.2.11 Viscosity

4.3.2.12 Environmental stress cracking

4.3.3 Chemical tests

4.3.3.1 Specific gravity

4.3.3.2 Density gradient

4.3.3.3 Compounding

4.3.3.4 Drying

4.3.3.5 Firing

4.3.3.6 Calcining

4.3.3.7 Water absorption

4.3.3.8 Measuring resistance to foreign materials

4.3.4 Thermal tests

4.3.4.1 Melting point

4.3.4.2 Fusing point

4.3.4.3 Flow rate (melt index)

4.3.4.4 Brittleness

4.3.5 Optical testing

4.3.5.1 Reflectance

4.3.5.2 Transmittance

4.3.5.3 Color determination

4.3.5.4 Weathering

4.3.6 Accoustical testing

4.3.6.1 Sound lab analysis

4.3.6.2 Reflection and absorption testing

4.3.7 Electro-magnetic testing

4.3.7.1 Conductivity

4.3.7.2 Dialectric constants

4.3.7.3 Resistance

4.3.7.4 Arc resistance

4.3.7.5 Magnetic constant

5.0 Processes

5.1 Forming

5.1.1 Clay forming processes

5.1.1.1 Slip casting

5.1.1.1.1 Plaster mold preparation

5.1.1.1.2 Prepare slip compound

5.1.1.1.3 Pour slip into mold by gravity

5.1.1.1.4 Dewatering of slip in the mold

5.1.1.1.5 Remove casting from open mold

5.1.1.1.6 Condition clay for maximum strength

5.1.1.1.7 Crystalline structure (inorganic)

5.1.1.1.8 Testing by fire

5.1.1.1.9 "Sticking up" fastening by slip (join), sponge and fettle

5.1.1.2 Jiggering

5.1.1.2.1 Prepare moist clay (compounding)

5.1.1.2.2 Form clay with jiggering machine tool

5.1.1.2.3 Preparation of profile (shaping method)

5.1.1.2.4 Desired stiffness of clay for workability

5.1.1.2.5 Crystalline structure of clay

5.1.1.2.6 "Sticking up" (joining with clay)

5.1.1.2.7 Sponge and fettle

5.1.1.3 Extrusion

5.1.1.3.1 Prepare die for shaping

5.1.1.3.2 Prepare compound or body similar to jiggering clay

5.1.1.3.3 Desired condition and stiffness of clay

5.1.1.3.4 Crystalline structure of clay

5.1.1.3.5 Assembly multiple parts with clay slip

5.1.1.3.6 Sponge and fettle

5.1.1.4 Compression-Ram

5.1.1.4.1 Preparation of mold-permanent or semi-permanent

5.1.1.4.2 Male and female die construction

5.1.1.4.3 Preparation of permeable gypsum material for dies-Gypsum cements

5.1.1.4.4 Clay charge similar to jiggering clay

5.1.1.4.5 Crystalling structure of clay (inorganic)

5.1.1.4.6 Assembly of multiple parts by "sticking up" join

5.1.1.4.7 Pressing the ware

5.1.1.4.8 Releasing the ware

5.1.1.4.9 Sponging and fettling

5.1.1.5 Compression-Dry press and semi-dry press

5.1.1.5.1 Preparation of clay compounds

5.1.1.5.2 Die construction

5.1.1.5.3 Clay charge (volumetric filling)

5.1.1.5.4 Compression pressures

5.1.1.5.5 Ejection of ware from die

5.1.1.6 Other clay manufacturing processes

5.1.1.6.1 Isostatic pressing

5.1.1.6.2 Vibratory compaction

5.1.1.6.3 Hot pressing

5.1.1.6.4 Fusion casting

5.1.1.6.5 Injection molding

5.1.1.6.6 Thin sheet forming

5.1.1.6.7 Gas pressure bonding

5.1.1.6.8 Explosive compacting

5.1.1.6.9 Throwing on the wheel

5.1.2 Glass forming processes

5.1.2.1 Blowing

5.1.2.2 Casting

5.1.2.3 Drawing

5.1.2.4 Float process

5.1.2.5 Pressing

5.1.2.6 Lamination

5.1.2.7 Slumping

5.1.2.8 Fabrication

5.1.3 Lapidary processes

5.1.3.1 Slabbing

5.1.3.2 Trimming

5.1.3.3 Polishing

5.1.3.4 Tumbling

5.1.3.5 Lapping

5.1.3.6 Faceting

5.1.3.7 Drilling

5.1.3.8 Dopping

5.1.3.9 Sanding

5.1.3.10 Orientation

5.1.3.11 Asterism

5.1.3.12 Preforming

5.1.3.13 Carving

5.1.3.14 Spherical grinding

5.1.4 Cement work

5.1.4.1 Compounding

5.1.4.2 Casting-setting

5.1.4.3 Finishing

5.1.5 Other masonry processes

5.2 Mold Making and Tooling

5.2.1 Product design

5.2.1.1 Psychological and physiological implications

5.2.1.2 Function

5.2.1.3 Aesthetics

5.2.1.4 Expressive colors in design

5.2.1.5 Good design attributes

5.2.2 Model making

5.2.2.1 Methods--carving, throwing, armature

5.2.2.2 Materials--wood, plaster, clay, plastic, rubber, industrial gypsum plasters

5.2.3 Block molds

5.2.4 Ring and case molds

5.2.5 Working molds for casting, jiggering, compressing

5.2.6 Dies for extruding

5.2.7 Templates for jiggering

5.3 Decoration and Firing

5.3.1 Decorating by cutting and carving

5.3.1.1 Incising

5.3.1.2 Piercing

5.3.1.3 Excising or relief carving

5.3.2 Sgraffito

5.3.3 Impressing

5.3.4 Applique

5.3.5 Glaze formation (See Glazes section 4.1.8)

5.3.5.1 Grinding

5.3.5.2 Mixing

5.3.5.3 Batch recipes

5.3.5.4 Test first batches

5.3.6 Basic methods of applying glaze

5.3.6.1 Spraying

5.3.6.2 Brushing

5.3.6.3 Pouring and dipping

5.3.6.4 Trailing

5.3.6.5 Stenciling

5.3.6.6 Penwork

5.3.7 Various decorating techniques

5.3.7.1 Glaze inlay

5.3.7.2 Majolica

5.3.7.3 Delft

5.3.7.4 Rubber resist

5.3.7.5 Onglaze

5.3.8 Firing

5.3.8.1 Bisque firing

5.3.8.2 Glaze firing

5.3.8.3 Firing process

5.3.8.3.1 Firing properties of clays

5.3.8.3.2 Completion of drying by firing

5.3.8.3.3 Removal of chemical water

5.3.8.3.4 Decomposition of carbonates and sulfates

5.3.8.3.5 Oxidation of organic matter

5.3.8.3.6 Recrystallization

5.3.8.3.7 Formation of glass

5.3.8.3.8 Firing shrinkage

5.3.8.3.9 Translucency

5.3.8.3.10 Absorption of fired bodies

5.3.8.4 Settings

5.3.8.4.1 Earthenware

5.3.8.4.2 Stoneware

5.3.8.4.3 Porcelain

5.3.8.4.4 Glost firing

5.3.8.4.5 Stilts, pins, shelves, supports

5.3.8.5 Firing schedules

5.3.8.5.1 Kiln maintainance and operation

5.3.8.5.2 Preheating

5.3.8.5.3 Rate of temperature rise

5.3.8.5.3.1 Thermoelectric pyrometery

5.3.8.5.3.2 Radiation pyrometers

5.3.8.5.3.3 Pyrometric cones

5.3.8.5.4 Cooling rates

INDUSTRIAL CERAMICS PHASE III

TEACHER & STUDENT ACTIVITIES

1.0 Cultural Applications

Refer to the books in the library for background materials on the history of ceramics past and present.

Chandler, Roy, Nelson and others

2.0 Ceramic Industries

Make a classification list of the various ceramic industries such as whitewares, sanitary wares, tile, brick, oxides, refractories, stone, cement, electro-ceramics, glass, etc.

Make a list of the various ceramic products in your home and/or community and identify the ceramic materials used in them. Students collect illustrations of products and collectively make bulletin board display within classifications.

Ceramic Industry Magazine

Gregor, Olson, Norton, Chandler & others

2.2 Careers

List the possible careers in the ceramic industries.

Invite people from the ceramic industries in to talk to the class.

3.0 Consumer Products Divisions

Make a list of ceramic materials such as stone, glass, cement, brick, tile, refractories, whitewares, abrasives, vitreous enamels, sanitary products, ceramic-electro ferrites, etc. Identify the specific application for each.

Describe the specific manufacturing processes, properties, products, and origin of materials for these ceramic materials.

Chandler, Gregor, and others

4.1 Material Types and Characteristics

Identify and describe the various raw materials used in ceramic products.

Make a list of specific uses of these materials.

4.2 Properties

Describe the various properties of ceramic materials.

Prepare ceramic materials by crushing and/or grinding with a hammer, file, etc.

Compound various clays for specific uses. Locate your own clay.

4.3 Testing

Make samples for testing of cement and/or gypsum cement for hardness, compressive strength, etc.

Make tests upon clay such as porosity, shrinkage, etc.

5.1 Forming Processes

Identify the various forming processes usually associated with the ceramic industry.

Identify the basic differences between these processes when it comes to actually forming the ceramic materials.

Try all the forming processes in the laboratory in so far as your equipment will allow.

5.1.1 Slip Casting

Prepare slip, pour into mold, pour excess from mold when desired wall thickness develops, allow to dry to green stage, remove from mold and allow to dry to bone condition, bisque fire (5.3.8.1), apply glaze (5.3.6), and glaze fire (5.3.8.2).

5.1.2 Jiggering

Prepare clay body for jiggering. Using jiggering attachment and mold on potter's wheel, form series of articles.

5.1.3 Extrusion and 5.2.6 Dies for Jiggering

Prepare clay to semi-moist condition; place in extruder to be molded in continuous pieces or cut to short lengths; extrude with extruding machine, pug mill, or food grinder using existing dies. Design new outline for die construction, cut pattern in die stock, and extrude new shape.

5.1.4 Compression-Ram

Prepare moist clay and place into plaster mold, compress with simple screw press or arbor press, allow to dry for removal from mold (repeat to make series of articles), dry to bone condition, bisque fire (5.3.8.1), apply glaze by first spraying and then stenciling pattern on the products (5.3.6).

5.1.5 Compression-Dry Press

Prepare clay, fill cavity of mold with measured amount of clay, compress in vise or arbor press, remove compressed part, glaze and fire in kiln.

5.1.9 Cement Work

Mix cement, 3 parts sand and 1 part cement, and cast in patio block mold. Experiment with alternate mix proportions and finish techniques--edging, textured surfaces, or make imprint into one of the surfaces.

Mix readi-mix and repair broken section of sidewalk.

5.2.1 Product Design

Design and construct models for the various processes.

5.2.5 Working Molds

Design a mold for the jiggering, slipcasting, and compression processes.

Design a profile for the jiggering process.

Gregor, Chandler, Olson, Kazanas and others

5.3 Decorating and Firing

Demonstrate use of the various decorating techniques that can be used in ceramics.

Prepare clay tiles, make samples using the various decorating techniques, glaze, and fire. Critique and record the results. Mix various glaze compositions, apply and fire. Critique and record the results. Stack, and fire the kiln and keep a firing log. Critique and record the results. Make a field trip to various ceramic industries.

NOTE: An excellent variety of school laboratory teacher/student activities are explained in the publication--Board of Education of the City of New York, Industrial Ceramics, Publication #00-5540-81 ($5.00 payable to Auditor, Board of Education), address: Publications Sales Office, 110 Livingston Street, Brooklyn, NY 11201.

INDUSTRIAL CERAMICS PHASE IV

REFERENCES

Printed Materials	Source	Topic(s)
Books:		
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Chaney, Charles and Skee, Stanley, Plaster Mold and Model Making, 1973	Van Nostrand Reinhold	5.2.2
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Dake, Henry C., The Art of Gem Cutting	Mineralogist Publishing	5.1.8
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Goldberg, Steven A., Glaze Calculation, 1970	Billiken Press	5.3.5
Gregor, Thomas G., Manufacturing Processes: Ceramics, 1976	Prentice-Hall	
Harper, Charles, Pottery Mold Making, 1966	Charles C. Harper	5.2.2
Johnson, W.R. and Newkirk, Louis V., The Ceramic Arts		

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Kinney, Kay, Glass Craft, 1962	Chilton	
Lindbeck, John R. and Lathrop, Irvin T., General Industry, 1969	Charles A. Bennett	
Long, Lois Culver, Ceramic Decoration	American Art Clay Company	5.3
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Olson, Delmar W., Industrial Arts for the General Shop, (Chapter Seven-The Ceramic Industries), 1968	Prentice-Hall	
Pough, Frederick H., A Field Guide to Rocks and Minerals, 1960	Houghton Mifflin	4.1.3
Quick, Leland and Leiper, Hugh, Gemcraft, How to Cut and Polish Gemstones, 1959	Chilton	5.1.8

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Sellers, Thomas, Throwing on the Potter's Wheel, 1960	Professional Publications	
Sinkankas, John, Gemstones of North America, 1959	D. Van Nostrand	4.1.3.4
Sperisen, Francis J., The Art of the Lapidary, 1961	Bruce	5.1.8
Stafford, Eugene C., Modern Industrial Ceramics, 1979	Bobbs-Merrill	
Tart, Carlie, The Beginner and the Wheel	American Art Clay Company	

Periodicals:

American Ceramic Society Bulletin	American Society Easton, Pa.
Ceramic Age	Ceramic Publications (Cleveland)
Ceramic Monthly	Professional Pub. (Columbus, Ohio)
Ceramic Industry	Cahners Pub. (Griston, CT)

Lapidary Journal	(San Diego, CA)

Pamphlets:

"Ceramics: Unlimited Horizons"	Aluminum Co. of America
"Aamaco Metal Enameling"	American Art Clay Company
"The Evolution of a Lump of Clay"	Coors Porcelain Company
"Glass in Science and Industry"	Corning Glass Works
"Fine China"	Lenox Inc.
"The Making of Portland Cement"	Portland Cement Association
"The Story of Fine China"	Syracuse China
"Master Caster"	United States Gypsum Company
"A Lecture Course of Coated Abrasives"	Behr-Manning (Troy, NY)

Audio-Visual Materials:

Craftsmanship in Clay Series	Audio-Visual Center Indiana University

LOCAL SOURCES OF

INDUSTRIAL CERAMICS INFORMATION

Blakeslee Prestress Inc., Route 139, Branford, CT 06405

Butler Concrete Products Co., Inc., Middlefield Industrial Park, Middlefield, CT 06455

Central Connecticut Precast Co., 347 East St., Plainville, CT 06062

Connecticut Precast Corp., 555 Fanhill Rd., Monroe, CT 06468

Cromwell Concrete Product, Inc., 667 Main St., Cromwell, CT 06416

Flexicore & Concrete Products, Durastone Flexicore Corp., Higginson Ave., Lincoln, R.I.

Milford Concrete Products, Inc., Div. D'Addario Industries, Honer Rd., Milford, CT 06460

Mr. Concrete-Patio Center & Step Co., Vol-Cast Corp., 340 Orange Center Rd., Orange, CT 06477

NuStone Industries, Inc., 355 Sackett Point Rd., North Haven, CT 06443

Plasticrete Block & Supply Corp., 99 Studdard Ave., North Haven, CT 06443

Valley Concrete Corp., Colt Highway, Farmington, CT 06032

Washington Concrete Products, Inc., 328 South Washington Ave., Plainville, CT 06062

Westbrook Concrete-Block Co., Inc., Cold Spring Brook Dr., Westbrook, CT 06498